

# Impact of Cancer on Health-Related Quality of Life of Older Americans

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- Background** The impact of cancer on health-related quality of life (HRQOL) is poorly understood because of the lack of baseline HRQOL status before cancer diagnosis. To our knowledge, this is the first population-based study to quantify the nature and extent of HRQOL changes from before to after cancer diagnosis for nine types of cancer patients and to compare their health with individuals without cancer.
- Methods** The Surveillance, Epidemiology, and End Results cancer registry data were linked with the Medicare Health Outcomes Survey (MHOS) data; data were collected from Medicare beneficiaries who were aged 65 years and older from 1998 through 2003. Cancer patients ( $n = 1432$ ; with prostate, breast, colorectal, lung, bladder, endometrial, or kidney cancers; melanoma; or non-Hodgkin lymphoma [NHL]) were selected whose first cancer diagnosis occurred between their baseline and follow-up MHOS assessments. Control subjects without cancer ( $n = 7160$ ) were matched to cancer patients by use of propensity scores that were estimated from demographics and comorbid medical conditions. Analysis of covariance models were used to estimate changes in HRQOL as assessed with the Medical Outcomes Study Short Form-36 survey (mean score = 50, SD = 10). All statistical tests were two-sided.
- Results** Patients with all cancer types (except melanoma and endometrial cancer) reported statistically significant declines in physical health (mean scores: prostate cancer =  $-3.4$ , 95% confidence interval [CI] =  $-2.5$  to  $-4.2$ ; breast cancer =  $-3.5$ , 95% CI =  $-2.5$  to  $-4.5$ ; bladder cancer =  $-4.3$ , 95% CI =  $-2.5$  to  $-6.1$ ; colorectal cancer =  $-4.4$ , 95% CI =  $-3.3$  to  $-5.5$ ; kidney cancer =  $-5.7$ , 95% CI =  $-3.2$  to  $-8.2$ ; NHL =  $-6.7$ , 95% CI =  $-4.4$  to  $-9.1$ ; and lung cancer =  $-7.5$ , 95% CI =  $-5.9$  to  $-9.2$ ) compared with the control subjects (mean score =  $-1.8$ , 95% CI =  $-1.6$  to  $-2.0$ ) (all  $P < .05$ ). However, only lung (mean score =  $-5.4$ , 95% CI =  $-3.5$  to  $-7.2$ ), colorectal (mean score =  $-3.5$ , 95% CI =  $-2.2$  to  $-4.7$ ), and prostate (mean score =  $-2.8$ , 95% CI =  $-1.8$  to  $-3.7$ ) cancer patients showed statistically significant decreases in mental health relative to the mean change of the control subjects (mean score =  $-1.2$ , 95% CI =  $-0.9$  to  $-1.4$ ) (all  $P < .05$ ).
- Conclusion** These findings provide validation of the specific deleterious effects of cancer on HRQOL and an evidence base for future research and clinical interventions aimed at understanding and remediating these effects.
- J Natl Cancer Inst 2009;101:860–868

The impact of cancer is often estimated in terms of clinical endpoints such as the risk of recurrence and the probability of remission and survival. These measures are essential yet do not fully capture the impact of cancer in terms of its effects on a person's functioning and well-being. For this reason, there has been growing interest in assessing health-related quality of life (HRQOL) as a means of more fully understanding the burden of cancer and evaluating the effects of cancer treatments.

The true impact of cancer on HRQOL, however, remains poorly understood because of critical limitations in research design and populations studied. Most cancer-related HRQOL studies have been limited to either highly selected populations of patients who are treated in specialized institutions or patients enrolled in randomized clinical trials (1). These studies, as well as larger, population-based observational studies in more heterogeneous

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**See "Funding" and "Notes" following "References."**

**DOI:** 10.1093/jnci/djp123

Published by Oxford University Press 2009.

patient populations, have typically measured baseline HRQOL only after the diagnosis has occurred and lack information on HRQOL of the patient before diagnosis. Comparison data for people without cancer have rarely been collected, thus limiting the ability to assess the additional impact of cancer, particularly among those with other chronic conditions (such as the elderly) that likely also affect HRQOL (2–8). To assess changes in HRQOL that are mainly attributable to the cancer and that are less likely related to other potentially confounding characteristics, prediagnosis assessments and comparisons of cancer patients with appropriate control groups are necessary. Yet, benchmark data that derive from studies with these design advantages have generally been limited. Only two studies (9,10) have been identified that include a HRQOL measurement before and after cancer diagnosis, and both studies focused exclusively on breast cancer. To date, no prospective longitudinal studies have examined the impact of cancer on HRQOL across multiple cancer sites and also used baseline health status assessments before cancer diagnosis.

The 2007 linkage of data from the Surveillance, Epidemiology, and End Results (SEER) program, a group of population-based cancer registries sponsored by the National Cancer Institute, with data from the Medicare Health Outcomes Survey (MHOS) sponsored by the Centers for Medicare & Medicaid Services provides a unique opportunity to assess the prospective impact of a diagnosis of cancer on HRQOL among older Americans (aged 65 years and older) across multiple cancer sites (11). Of interest are those individuals whose cancer diagnosis occurred between the MHOS baseline assessment and the follow-up assessment. In addition, the availability of MHOS data for persons living in SEER geographic areas but without a cancer diagnosis allows for a measurement of the additive impact of a cancer diagnosis on HRQOL beyond what might be expected for a group of older adults in the general community.

In this article, we compare the prospective changes in HRQOL for a group of older patients diagnosed with cancer across nine cancer sites that occur within 2 years of their diagnosis with changes in HRQOL in a similar time frame among a set of matched control subjects drawn from the same population base. We expect this study to provide a benchmark for capturing the burden of cancer on HRQOL and an evidence base for future research and clinical interventions aimed at understanding and remediating these effects.

## Methods

### Individuals in This Study

The current study examined the burden of a cancer diagnosis and treatment on the HRQOL of individuals aged 65 years and older who were enrolled in Medicare managed care plans. This study represents a collaboration between two US Federal agencies: the Centers for Medicare & Medicaid Services and the National Cancer Institute. Under this collaboration, survey data from the MHOS of the Centers for Medicare & Medicaid Services (12) were linked in 2007 with data from SEER cancer registries from the National Cancer Institute (13). The MHOS is a yearly survey that is administered to a random sample of 1000 Medicare beneficiaries from each managed care plan under contract with the Centers for Medicare & Medicaid Services. Each participant, selected from the random drawing, is asked to complete a survey

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## CONTEXT AND CAVEATS

### Prior knowledge

How cancer impacts health-related quality of life is not clearly understood because health-related quality of life before cancer is often not measured or compared to individuals without cancer.

### Study design

Data from the Medicare Health Outcomes Survey were linked with the National Cancer Institute's Surveillance, Epidemiology, and End Results cancer registry data which includes Medicare beneficiaries aged 65 years and older from 1998 through 2003. Mean survey scores of cancer patients ( $n = 1432$ ) were compared with those of matched control subjects without cancer ( $n = 7160$ ).

### Contribution

All cancer patients, except melanoma and endometrial cancer, had lower mean physical health scores than control subjects, but only patients with colorectal, prostate, and lung cancers had lower mean mental health scores than control subjects. Patients with prostate, bladder, colorectal, kidney, or lung cancer or NHL reported greater declines in their social roles and well-being than controls.

### Implications

The effects of cancer on health-related quality of life in this study population were specific, and these results provide a basis for future research and treatments to target these effects.

### Limitations

It is unknown how representative the cohort in this study is to US cancer patients in this age range. Some cancer types had few patients, so the statistical power to detect important changes was reduced in these groups. Disease severity, treatment, and timing of survey completion related to the date of cancer diagnosis were not included in the analysis.

*From the Editors*

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at baseline and 2 years later if they are still enrolled in the same plan (follow-up). The SEER program collects information about all patients with newly diagnosed (incident) cancer in populations within specific geographic areas. A detailed description of the SEER–MHOS data linkage is provided elsewhere (11).

The linked SEER–MHOS dataset included four MHOS cohorts for the following baseline through follow-up years: 1998–2000, 1999–2001, 2000–2002, and 2001–2003. Response rates on the baseline survey in SEER regions ranged from 64.1% in 1998 to 71.6% in 2000 (11). Follow-up response rates ranged from 76.3% to 84.9%, resulting in a sample size of 11 683 MHOS respondents linked to SEER across the four cohorts (11). An independent study of the MHOS 2000 dataset examined the extent of potential nonresponse bias (14). This study linked individual-level survey data to the sample file, Medicare enrollment data, and Medicare risk adjustment data, as an independent method of comparing the health status of survey responders vs nonresponders. The major finding was that although nonresponders were older, more likely to be another race other than white, and of slightly poorer health status than responders, these differences did not persist when averages were calculated at the managed care plan level. It is thus reasonable to assume that response bias is minimal in the current study, which uses four MHOS cohorts and combines

data across 101 managed care plans. Thus, this study aggregated data at a higher level than was examined in the previous study on nonresponse bias (14).

To prospectively evaluate the impact of a cancer diagnosis on patients' HRQOL, we selected cancer patients in the dataset whose first SEER-confirmed cancer diagnosis occurred between the completed baseline and the follow-up MHOS. By pooling across the four cohorts, we identified 1432 persons with cancer who had data on both the baseline and the follow-up MHOS. The mean time from cancer diagnosis to follow-up MHOS was 12.4 months (range = 0–32 months after diagnosis). The sample included 436 prostate, 320 breast, 240 colorectal, 112 non-small cell lung, 89 bladder, 56 endometrial, 53 non-Hodgkin lymphoma (NHL), and 46 kidney cancer patients and 80 melanoma patients. Selection of 30964 respondents without cancer to the MHOS was limited to those who resided in the same SEER region and participated in the same managed care plans as the cancer patients.

### Data Collected

The primary goals for the collection of MHOS data were for Centers for Medicare & Medicaid Services to evaluate the performance of the managed care plans under contract with Centers for Medicare & Medicaid Services, to promote quality improvement, and to empower beneficiaries with the knowledge of program performance to make plan selections (12,15). The MHOS provides data on patient sociodemographics, survey characteristics, chronic medical conditions, clinical symptoms, HRQOL (physical and mental health), and smoking status.

The MHOS includes the Medical Outcomes Study Short Form-36 (SF-36, version 1) (16), a standardized survey used to measure HRQOL that has been widely used in general and disease-specific populations, including cancer (17). The SF-36 has eight scales: physical functioning (10 items), role-physical (four items), bodily pain (two items), general health (five items), vitality (four items), social functioning (two items), role-emotional (three items), and mental health (five items). The eight scales provide the basis for calculating two summary scores: the physical component summary and the mental component summary. Each summary score is derived from a weighted combination of all eight scales, with higher weights on physical functioning, role-physical, bodily pain, and general health for the physical component summary and with higher weights on mental health, role-emotional, social functioning, and vitality for the mental component summary. SF-36 scores on the subscales and the summary scales are normalized to the general US population on a *T*-score metric (mean score = 50, SD = 10). Higher scores reflect better health.

The MHOS also includes a self-reported measurement of activities of daily living. The activities of daily living scale assesses difficulties with six items: bathing, dressing, eating, getting in or out of chairs, walking, and using the toilet.

Demographic variables in the MHOS included self-reported education, age, sex, race and ethnicity, current marital status, and change in marital status between baseline and follow-up assessment. Survey characteristics included survey administration (mailed or interviewer administered) and whether the survey was completed by the Medicare recipient directly or by a proxy. Chronic medical conditions included hypertension or high blood pressure, coronary

artery disease, congestive heart failure, myocardial infarction or heart attack, other heart conditions, stroke, chronic obstructive pulmonary disease, inflammatory bowel disease, arthritis of the hip or knee, arthritis of the hand or wrist, sciatica, and diabetes.

We classified chronic medical conditions that existed before the baseline MHOS assessment as “preexisting” conditions and classified conditions that were diagnosed between baseline and follow-up MHOS assessments as “newly diagnosed” conditions. We developed four comorbidity indices by using weights that were based on the burden of the condition on HRQOL. These comorbidity weights were derived from a separate MHOS sample of individuals (independent of the patients or control subjects used in main analyses). It included respondents without cancer (*n* = 13 705) and respondents with cancer at the baseline MHOS (*n* = 1398). Separate indices were created for physical and mental health as the outcome and whether the conditions were preexisting or newly diagnosed. The weighted indices were used rather than a simple count to avoid treating each condition as having equal impact on HRQOL.

The SEER program currently includes 18 population-based cancer registry sites that represent 26% of the US population (13). Fourteen registries are represented in the SEER–MHOS dataset. We did not include disease severity (eg, stage at diagnosis) and treatment variables available in the SEER data because the analysis compared HRQOL change scores in people with cancer relative to control subjects without cancer for whom such variables were not pertinent. In addition, incorporating disease-specific variables would greatly complicate the analysis and interpretation because of considerable variation across cancer types with respect to measures of disease severity and treatment characteristics.

### Statistical Analysis

To minimize potential confounding when examining HRQOL differences between the case patients with cancer and the control subjects without cancer, control subjects were matched to case patients by use of propensity score–matching procedures (18–20) as described in detail elsewhere (21). Matching was based on patient demographics, survey characteristics, and preexisting diagnosed chronic medical conditions other than cancer. Five control subjects were matched to each case patient with cancer to account for possible bias due to confounding from unmeasured variables in the study (22).

An analysis of covariance (ANCOVA) model was used to examine the change in HRQOL scores for people diagnosed with cancer relative to control subjects after adjustment for baseline HRQOL scores. Covariates included the weighted preexisting and newly diagnosed comorbid condition indices (continuous); education level (eighth grade or less, some high school, high school graduate or General Education Development degree, some college or a 2-year degree, or college graduate or higher); age (continuous); sex (male or female); race or ethnicity (white, Asian, black, Hispanic, American Indian, or other); baseline marriage status (married, never married, divorced, or widowed); widowed, divorced, or separated between baseline and follow-up (no or yes); smoking status (never, former, or current); self- or interviewer-administered; and self-report or proxy response. A mixed-effect ANCOVA model was used to adjust for clustering due to participation in the same managed health-care plans and clustering due to the five-to-one control subject to case patient matching of the data (23).

Adjustments that used Dunnett–Hsu adjusted *P* values were made for multiple comparisons for change in HRQOL among the cancer groups and control subjects ( $\alpha < .05$ ). Results from the adjusted model were compared with an unadjusted model, and the findings were similar; the adjusted estimates are reported in this article. All statistical tests were two-tailed and all analyses were performed with SAS version 9.13 (SAS Institute, Inc., Cary, NC).

The size of the HRQOL change scores from baseline to follow-up assessment was also compared with minimally important difference estimates (24,25). A half SD (5-point change) was used in these analyses (26). This change corresponds to Cohen’s definition of a medium effect size (27) and can be considered to be clinically relevant (28,29).

## Results

### Sample Description

The characteristics for the case patients (*n* = 1432) and the matched control subjects (*n* = 7160) were compared (Table 1). Because of propensity score matching, no statistically significant differences were observed between case patients and control subjects on such key variables as education, sex, race, preexisting comorbidities, and smoking status. The only statistically significant differences between the two groups was that cancer patients experienced higher levels of newly diagnosed “other heart conditions” between baseline and follow-up survey than noncancer control subjects (9%–7%, respectively; *P* = .006) and that cancer patients had more proxy reporting at follow-up survey than noncancer control subjects (13%–10%, respectively; *P* < .001). All covariates including newly diagnosed other heart conditions and proxy reporting were controlled for in the following analyses when comparing HRQOL changes over time between individuals with and without cancer.

### Change in Physical Health

At baseline, the mean SF-36 physical component summary score for the control subjects was 43.2 (SD = 12.1) and that for the case patients ranged between 40.8 (SD = 11.8) for lung cancer and 45.2 (SD = 10.3) for NHL. These baseline means are consistent with age-adjusted general US population 1998 norms for the SF-36 physical component summary for individuals aged 65 years or older (ie, men = 41.95 and women = 41.02) (30). We compared adjusted mean changes in the physical component summary score from baseline with follow-up assessment by type of cancer (Figure 1). Patients with all cancer types examined (except for melanoma and endometrial cancer) reported statistically significantly greater decline in physical component summary scores (mean scores: prostate cancer = −3.4, 95% confidence interval [CI] = −2.5 to −4.2; breast cancer = −3.5, 95% CI = −2.5 to −4.5; bladder cancer = −4.3, 95% CI = −2.5 to −6.1; colorectal cancer = −4.4, 95% CI = −3.3 to −5.5; kidney cancer = −5.7, 95% CI = −3.2 to −8.2; NHL = −6.7, 95% CI = −4.4 to −9.1; and lung cancer = −7.5, 95% CI = −5.9 to −9.2) than the matched control subjects (mean score = −1.8, 95% CI = −1.6 to −2.0, *P* < .05). Kidney, NHL, and non-small cell lung cancer patients reported the greatest decline in physical health that was larger than a half SD.

We next examined the adjusted mean changes in the four physical health scales of the SF-36 (Table 2). The cancer groups are listed

**Table 1.** Comparison of covariates for cancer patients and matched control subjects without cancer\*

Characteristic	Cancer patients ( <i>n</i> = 1432)	Matched noncancer control subjects ( <i>n</i> = 7160)
<b>Education, %</b>		
8th grade or less	11.10	10.38
Some high school	15.08	14.19
High school graduate or GED degree	29.89	31.28
Some college or 2-year degree	24.09	24.73
College graduate or higher	19.83	19.41
<b>Mean age (SD), y</b>	73.86 (5.85)	73.81 (6.04)
<b>Sex, %</b>		
Male	55.45	55.54
Female	44.55	44.46
<b>Race, %</b>		
White	81.63	81.76
Asian	5.80	5.88
Black	5.24	4.96
Hispanic	5.87	5.80
American Indian	0.63	0.60
Other	0.70	0.67
<b>Marriage status (baseline), %</b>		
Married	64.87	64.69
Never married	2.23	2.12
Divorced	9.57	9.57
Widow	21.44	21.66
<b>Widowed, divorced, or separated from baseline to follow-up, %</b>		
No	96.44	96.42
Yes	3.56	3.58
<b>Smoking status, %</b>		
Never	36.45	36.31
Former	44.76	44.58
Current	12.29	12.42
<b>Assessment mode mixed from baseline to follow-up, %</b>		
No	86.66	86.62
Yes	13.34	13.38
<b>Proxy (baseline), %</b>		
No	85.61	85.41
Yes	7.61	7.79
<b>Proxy (follow-up), %</b>		
No	79.47	81.94
Yes	12.64	9.66†
<b>Preexisting conditions, %</b>		
Hypertension or high blood pressure	51.82	52.42
Angina pectoris or coronary artery disease	14.66	14.79
Congestive heart failure	5.73	6.09
Myocardial infarction or heart attack	9.50	9.43
Other heart conditions	21.30	20.81
Stroke	6.01	6.56
Emphysema, asthma, or COPD	13.69	13.66
Crohn disease, ulcerative colitis, or IBD	3.98	4.04
Arthritis of the hip or knee	33.80	34.62
Arthritis of the hand or wrist	29.54	29.05
Sciatica	20.95	20.71
Diabetes	15.43	15.21

(Table continues)



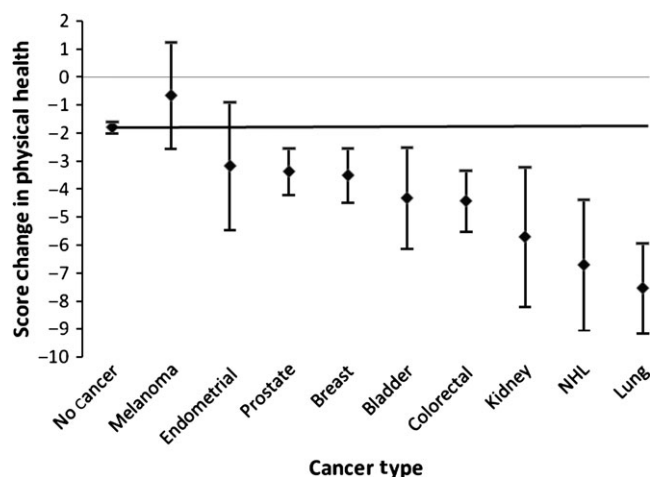
**Table 1 (continued).**

Characteristic	Cancer patients (n = 1432)	Matched noncancer control subjects (n = 7160)
Newly diagnosed conditions, %		
Hypertension or high blood pressure	8.87	8.17
Angina pectoris or coronary artery disease	4.82	5.01
Congestive heart failure	3.49	3.60
Myocardial infarction or heart attack	3.00	3.92
Other heart conditions	9.08	7.00†
Stroke	3.91	3.32
Emphysema, or asthma, COPD	4.75	3.90
Crohn disease, ulcerative colitis, or IBD	3.00	2.29
Arthritis of the hip or knee	11.10	10.10
Arthritis of the hand or wrist	9.99	11.08
Sciatica	7.33	8.62
Diabetes	4.75	3.80

\* All patient characteristics (except widowed, separated, or divorced from baseline to follow-up), survey characteristics (except proxy at follow-up), and preexisting conditions were matched between individuals with and without cancer. GED = General Education Development; COPD = chronic obstructive pulmonary disease; IBD = inflammatory bowel disease.

†  $P < .01$ , cancer patients vs control subjects, as calculated using a two-sided  $\chi^2$  test.

by severity in terms of decrease in the physical component summary score since precancer diagnosis. With the exception of bodily pain, we observed a statistically significantly greater decline in physical health of patients with a majority of the cancer types than that of control subjects without cancer. The greatest changes were observed in the role limitations due to physical health problems, a scale that includes items on reducing the amount of time spent on work and



**Figure 1.** The adjusted mean decline in the Short Form-36 (version 1) physical component summary scores from baseline to follow-up assessment across the nine cancer types and the control subjects (No Cancer). The samples included 436 prostate, 320 breast, 240 colorectal, 112 non-small cell lung, 89 bladder, 56 endometrial, 53 non-Hodgkin lymphoma (NHL), and 46 kidney cancer patients; 80 melanoma patients; and 7160 control subjects. The horizontal line provides a reference to the mean change in score of the control subjects.

other activities and limiting the kind of activities individuals performed. Only the lung cancer patients showed a statistically significant increase in bodily pain compared with control subjects.

Given the large decreases in physical functioning, we further explored how respondents' activities of daily living were affected by a cancer diagnosis. Lung cancer patients experienced the greatest decline in activities of daily living among the cancer types, most notably difficulties with bathing (25% reporting some difficulty or unable to do compared with 13% for control subjects), dressing (20% compared with 11% for control subjects), eating (13% compared with 5% for control subjects), getting in or out of chairs (35% compared with 25% for control subjects), and using the toilet (16% compared with 7% for control subjects). Colorectal cancer patients reported greater difficulty with bathing (21% compared with 13% for control subjects), dressing (18% compared with 11% for control subjects), eating (10% compared with 5% for control subjects), and getting in or out of chairs (37% compared with 25% for control subjects). Kidney cancer patients reported greater difficulty with getting in or out of chairs (43% compared with 25% for control subjects) and walking (48% compared with 33% for control subjects). Prostate cancer patients reported more difficulty with using the toilet (10%) than control subjects (7%).

### Change in Mental Health

At baseline, the mean mental component summary score for the control group was 52.3 (SD = 11.3) and that for the cancer patients ranged between 51.0 (SD = 11.9) for colorectal cancer and 54.0 (SD = 9.8) for NHL. These baseline means are consistent with age-adjusted 1998 US population norms for the SF-36 mental component summary for individuals aged 65 years and older (ie, men = 52.51 and women = 51.44) (30). The adjusted mean changes in the SF-36 mental component summary scores across cancer types were compared (Figure 2). Only the scores in mental component summary for lung (mean score = -5.4, 95% CI = -3.5 to -7.2), colorectal (mean score = -3.5, 95% CI = -2.2 to -4.7), and prostate (mean score = -2.8, 95% CI = -1.8 to -3.7) cancer patients showed statistically significant decreases relative to the control subjects (mean score = -1.2, 95% CI = -0.9 to -1.4), with the mean change for lung cancer patients exceeding one-half of the SD.

The adjusted mean changes in the four SF-36 mental health scales across cancer types were examined (Table 3). At the scale level, large and statistically significant decreases in social function were observed for patients with prostate, bladder, colorectal, kidney, or lung cancer, and NHL. Lowered vitality (ie, greater fatigue) was reported for patients with prostate, breast, colorectal, and lung cancer and NHL.

### Association of Covariates

A number of covariates used in the regression models were statistically significantly associated with changes in physical and mental health status independent of the presence of cancer. Most of these associations were expected. For example, patients with newly diagnosed comorbid conditions, with lower education levels, who were current smokers, or who had a proxy respondent at follow-up survey were associated with decreases in all the physical health scales (physical component summary, physical functioning, role-physical,

**Table 2.** Adjusted change in physical health status from before to after cancer diagnosis as measured by the Short Form-36 (version 1)\*

Cancer type	No. of patients	Physical function, mean (95% CI)	Role limitations, physical, mean (95% CI)	Bodily pain, mean (95% CI)	General health perceptions, mean (95% CI)
No cancer	7160	−1.9 (−1.7 to −2.1)	−2.2 (−1.9 to −2.6)	−1.1 (−0.9 to −1.3)	−1.4 (−1.3 to −1.6)
Melanoma	80	−0.7 (1.1 to −2.5)	−0.4 (2.6 to −3.5)	0.4 (2.3 to −1.4)	−0.6 (1.0 to −2.1)
Endometrial	56	−1.5 (0.6 to −3.7)	−5.5 (−1.8 to −9.1)†	−1.9 (0.3 to −4.1)	−2.0 (−0.1 to −3.9)
Prostate	436	−3.1 (−2.3 to −3.9)‡	−4.9 (−3.6 to −6.3)‡	−1.8 (−1.0 to −2.6)	−3.6 (−2.9 to −4.3)‡
Breast	320	−2.4 (−1.5 to −3.4)	−5.7 (−4.2 to −7.3)†,‡	−1.9 (−1.0 to −2.9)	−3.0 (−2.2 to −3.8)‡
Bladder	89	−4.1 (−2.4 to −5.8)	−5.8 (−2.9 to −8.7)†	−2.0 (−0.2 to −3.7)	−4.1 (−2.6 to −5.5)‡
Colorectal	240	−3.7 (−2.7 to −4.8)‡	−6.6 (−4.9 to −8.4)†,‡	−2.3 (−1.2 to −3.4)	−4.2 (−3.3 to −5.1)‡
Kidney	46	−5.3 (−2.9 to −7.7)†,‡	−8.6 (−4.6 to −12.6)†,‡	−1.6 (0.8 to −4.0)	−5.8 (−3.7 to −7.9)†,‡
NHL	53	−5.6 (−3.4 to −7.8)†,‡	−9.9 (−6.2 to −13.7)†,‡	−2.3 (0.0 to −4.6)	−5.8 (−3.8 to −7.7)†,‡
Lung	112	−7.0 (−5.4 to −8.5)†,‡	−10.4 (−7.9 to −13.0)†,‡	−4.2 (−2.6 to −5.8)‡	−7.4 (−6.0 to −8.7)†,‡

\* Change scores were adjusted for baseline status (continuous); preexisting and newly diagnosed comorbid conditions (continuous indices); education level (eighth grade or less, some high school, high school graduate or General Education Development degree, some college or 2-year degree, or college graduate or higher); age (continuous); sex (male or female); race or ethnicity (white, Asian, black, Hispanic, American Indian, or other); baseline marriage status (married, never married, divorced, or widowed); widowed, divorced, or separated between baseline and follow-up (no or yes); smoking status (never, former, or current); self- or interviewer-administered; and self-report or proxy response. SEs to derive the 95% CIs were adjusted for clustering effects due to health-care plan and matched design for the case-control study. CI = confidence interval. NHL = non-Hodgkin lymphoma.

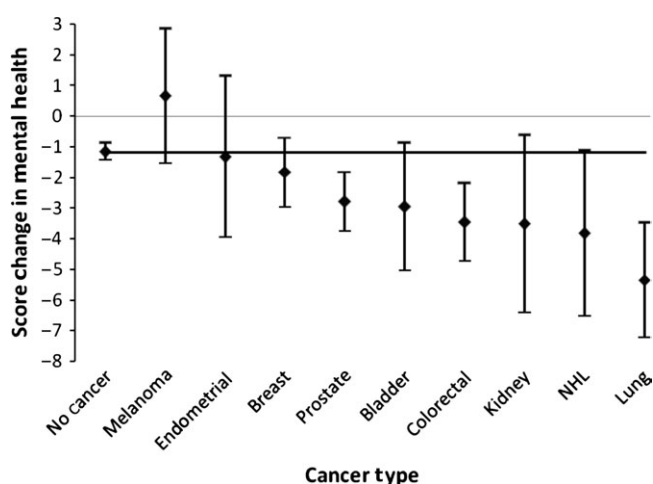
† The mean decline in physical health was above the minimally important difference of one-half of an SD.

‡ Cancer group change score was statistically significantly different from the noncancer group change score after adjusting for multiple comparisons with the Dunnnett-Hsu test (two-sided) ( $P < .05$ ).

bodily pain, and general health). Increased age was associated with decreases in all the physical health scales, except bodily pain. Patients who were widowed, separated, or divorced between baseline and follow-up surveys were more likely to have declines in mental health and more role limitations in functioning due to mental health. Current smokers and those with lower education levels also reported greater declines in mental health outcomes.

## Discussion

This longitudinal population-based study examined the impact of a new cancer diagnosis on HRQOL among older Americans.



**Figure 2.** The adjusted mean decline in the Short Form-36 mental component summary scores from baseline to follow-up assessment across the nine cancer types and the control subjects (No Cancer). The samples included 436 prostate, 320 breast, 240 colorectal, 112 non-small cell lung, 89 bladder, 56 endometrial, 53 non-Hodgkin lymphoma, and 46 kidney cancer patients; 80 melanoma patients; and 7160 control subjects. The horizontal line provides a reference to the mean change in score of the control subjects.

Before their cancer diagnosis, cancer patients in this study reported physical and mental health scores similar to a control group without cancer. Notable decrements in HRQOL, relative to the control group, were reported after a cancer diagnosis across most cancer sites. To our knowledge, this is the first study to report HRQOL changes from before to after cancer diagnosis across nine different cancer sites, compared with a matched control group of older adults without cancer. Study findings thus enhance our understanding of the impact of the cancer diagnosis and treatment on older patients' physical, mental, and social well-being and their daily functioning.

Understanding the impact of cancer on quality of life is an issue of great importance, given the more than 1 million patients with a new diagnosis of cancer each year (31) and the ever-growing number of cancer survivors in the United States (estimated at 11.1 million in 2005, with 60% being aged 65 years and older) (32). Substantial variation in the natural history, clinical manifestations, and treatment of different cancers further raises the need to understand how these cancers affect HRQOL. Such an understanding might allow clinicians to better anticipate—and therefore more effectively detect, prevent, and treat—the physical and psychosocial sequelae of both cancer and its treatment. To this end, the current study provides initial benchmarks of the impact of cancer on functioning and well-being among patients across nine different cancer sites. It also parses out the impact of the cancer diagnosis from that of other comorbid health conditions and sociodemographic factors.

Overall, we observed several cancer-specific differences in the effect of cancer on the physical dimension of HRQOL, with kidney, NHL, and non-small cell lung cancer patients reporting the greatest deficits. Furthermore, when we examined specific components of physical health, we saw that these effects were most prominent in the reported role limitations due to physical problems. The reasons for these differences by cancer site represent an important area for future research. Variations in impact of cancer

**Table 3.** Adjusted change in mental health status from before to after cancer diagnosis as measured by the Short Form-36 (version 1)\*

Cancer type	No. of patients	Mental health, mean (95% CI)	Role limitations, mental, mean (95% CI)	Vitality, mean (95% CI)	Social function, mean (95% CI)
No cancer	7160	−0.8 (−0.6 to −1.0)	−2.0 (−1.6 to −2.4)	−1.5 (−1.2 to −1.7)	−1.6 (−1.3 to −1.8)
Melanoma	80	0.5 (2.2 to −1.2)	0.6 (4.0 to −2.9)	0.0 (1.7 to −1.8)	−0.3 (1.7 to −2.4)
Endometrial	56	−0.4 (1.7 to −2.4)	−2.8 (1.4 to −6.9)	−2.2 (−0.1 to −4.3)	−3.0 (−0.6 to −5.5)
Prostate	436	−1.5 (−0.7 to −2.2)	−4.8 (−3.3 to −6.3)‡	−2.7 (−1.9 to −3.4)‡	−3.4 (−2.5 to −4.3)‡
Breast	320	−1.2 (−0.3 to −2.1)	−3.5 (−1.7 to −5.2)	−2.8 (−1.9 to −3.7)‡	−2.4 (−1.3 to −3.4)
Bladder	89	−2.6 (−1.0 to −4.3)	−3.3 (0.0 to −6.5)	−3.6 (−1.9 to −5.3)	−5.2 (−3.2 to −7.1)†,‡
Colorectal	240	−1.7 (−0.7 to −2.7)	−5.0 (−3.0 to −7.0)†,‡	−4.5 (−3.5 to −5.5)‡	−5.3 (−4.1 to −6.5)†,‡
Kidney	46	−1.4 (0.9 to −3.6)	−6.1 (−1.6 to −10.6)†	−4.5 (−2.2 to −6.8)	−5.9 (−3.2 to −8.6)†,‡
NHL	53	−2.3 (−0.2 to −4.3)	−5.6 (−1.4 to −9.8)†	−6.1 (−3.9 to −8.2)†,‡	−6.2 (−3.7 to −8.7)†,‡
Lung	112	−3.6 (−2.1 to −5.0)‡	−8.2 (−5.3 to −11.1)†,‡	−5.6 (−4.1 to −7.1)†,‡	−8.2 (−6.5 to −9.9)†,‡

\* Change scores were adjusted for baseline status (continuous); preexisting and newly diagnosed comorbid conditions (continuous indices); education level (eighth grade or less, some high school, high school graduate or General Education Development degree, some college or 2-year degree, or college graduate or higher); age (continuous); sex (male or female); race or ethnicity (white, Asian, black, Hispanic, American Indian, or other); baseline marriage status (married, never married, divorced, or widowed); widowed, divorced, or separated between baseline and follow-up (no or yes); smoking status (never, former, or current); self- or interviewer-administered; and self-report or proxy response. SEs to derive the 95% CIs were adjusted for clustering effects due to health-care plan and matched design for the case-control study. CI = confidence interval. NHL = non-Hodgkin lymphoma.

† The mean decline in physical health was above a minimally important difference of one-half of an SD.

‡ Cancer group change score was statistically significantly different from the noncancer group change score after adjusting for multiple comparisons with the Dunnnett-Hsu test (two-sided) ( $P < .05$ ).

on HRQOL may reflect differences in the natural history and clinical manifestations of different malignancies; the effectiveness and side effects of different cancer treatments; or the amount, nature, or effectiveness of palliative treatments given to patients with different cancers. Further corroborating the need for future research to isolate these factors, for most patients, reports of bodily pain did not differ from those reported by individuals without cancer. Only lung cancer patients reported statistically significantly more bodily pain than the control group.

We found that patients with prostate, colorectal, or non-small cell lung cancer experienced statistically significantly decreased mental health relative to matched control subjects without cancer. Similar to physical health, the greatest negative effects of cancer were found in reported role limitations due to mental problems. Furthermore, these effects were cancer specific, with prostate, bladder, colorectal, kidney, and lung cancers, and NHL being associated with the greatest decreases in social functioning. The causes of these cancer-specific differences represent an important area for future research, particularly in light of the differences in physical health declines across these cancer types. These data highlight the importance of health effects on social roles and underscore the need for clinicians to assess both the psychological and the social well-being of their cancer patients and to maximize psychosocial support interventions (33).

Our study has many important advantages over previous studies of prospective changes in HRQOL that typically capture baseline status before the initiation of therapy but after cancer diagnosis (34–36). To avoid contamination of the baseline assessment due to the impact of a cancer diagnosis on a patient's health and well-being, it is necessary to measure baseline HRQOL before the diagnosis. Two previous studies examined HRQOL both before and after diagnosis but were limited to breast cancer. The larger study was the Nurses' Health Study (9), which identified 759 female nurses who were diagnosed with breast cancer between an initial HRQOL survey in 1992 and a follow-up survey in 1996.

Several analyses of this dataset have been published. Michael et al. (37) found that women with breast cancer were more likely to have more role limitations due to physical health problems; greater bodily pain; and worse physical functioning, vitality, and social function than those in a noncancer cohort. Analyzing the same dataset, Nekhyudov et al. (38) focused on women with ductal carcinoma in situ and reported declines in vitality and social function and increased role limitations due to physical health relative to women without cancer. In another analysis, Kroenke et al. (39) found statistically significant decreases in physical function, social function, and emotional role function, and greater role limitations due to physical health among breast cancer patients aged 65 years or older.

The other study examining HRQOL before and after diagnosis of cancer (10) used a smaller cohort of women who were residents of Beaver Dam, Wisconsin, and examined change for women who completed a baseline survey between 1988 and 1990 with follow-up surveys 5 and 10 years later. The 26 women who were diagnosed with breast cancer between the baseline and the follow-up surveys suffered statistically significant declines relative to control subjects in all SF-36 subscales, except role limitations due to mental health problems. The current study corroborates the main findings of these two earlier breast cancer-specific studies (9,10), demonstrating that the greatest changes in HRQOL after breast cancer were in vitality and role limitations due to physical health problems, as opposed to mental health.

Other published studies on elderly Americans were limited to assessing HRQOL after cancer diagnosis. Three studies used national surveys and compared multiple cancer types (self-reported) with individuals without cancer. Baker et al. (2) compared cancer patients with matched control subjects in the 1998 MHOS cohort and found that patients with prostate, breast, colorectal, or lung cancer who were currently undergoing treatment had poorer physical health and that patients with breast, colorectal, or lung cancer reported poorer mental health. Smith

et al. (8) performed a cross-sectional analysis across four MHOS cohorts and found patients with all cancer types (NHL and lung, kidney, endometrial, colorectal, breast, prostate, and bladder cancers) except melanoma to have statistically significantly worse physical health than patients without cancer. Furthermore, patients with NHL or lung, bladder, breast, or colorectal cancer reported lower mental health scores than individuals without cancer. Hewitt et al. (3) compared cancer survivors with those without cancer by use of the National Health Interview Survey (years 1998–2000) and found that cancer survivors overall were more likely to report fair or poor health, psychological disability, and limitations in activities of daily living. Compared with women with breast cancer, individuals with a history of lung cancer or NHL reported poorer overall health. Thus, the existing cross-sectional data examining relationships between cancer and HRQOL are consistent with our findings.

In this study, we go beyond the earlier studies (2,3,8–10) by estimating the magnitude of change in HRQOL from before to after diagnosis among nine cancers (breast, prostate, colorectal, non-small cell lung, kidney, endometrial, melanoma, and bladder cancers, and NHL) to determine the impact of cancer relative to older Americans without cancer. The large sample of older adults without cancer permitted us to measure the additive effects of cancer on HRQOL in the presence of many potentially confounding demographic and health factors. Furthermore, the linkage of patient survey data with SEER cancer registry data provided a novel database with numerous advantages over survey data alone. Linked registry data enabled us to identify the month and year of initial diagnosis, which was then used as the index date for assessments before and after the survey and also provided a more valid method to identify the clinical characteristics of the cancers diagnosed compared with patient self-reports.

This study also has limitations. Only cancer patients who were members of Medicare managed care plans were included in the MHOS, and thus this study is limited to those beneficiaries. It is not clear whether this cohort is representative of all elderly patients in the SEER areas or whether managed care enrollees are generally healthier than Medicare fee-for-service beneficiaries. The evidence is mixed, with some studies (40,41) indicating that managed care enrollees are healthier than fee-for-service beneficiaries and another study (42) indicating that the health status is similar between the programs.

In addition, sample sizes were small for some of the cancer sites, thus reducing the power to detect statistically significant effects of the cancer diagnosis on HRQOL. For example, patients with bladder or kidney cancer or NHL had larger decreases in mental health scores than patients with prostate cancer, but those differences were not found to be statistically significantly different from those of control subjects. Another important limitation is that these data do not capture those cancer patients (or control subjects) who disenrolled from the plan or died before their follow-up HRQOL survey (43). It is difficult to estimate the effect of response bias; however, the HRQOL change scores likely reflect the lower bounds of decreased physical and mental health especially for patients with colorectal or lung cancer or NHL, who are typically diagnosed in late stages of disease.

We did not incorporate variables on disease severity, treatments received, and survey timing relative to the date of diagnosis because the primary aim was to provide a broad overview of the impact of many different cancer diagnoses on HRQOL relative to changes occurring in matched control subjects without cancer. In addition, incorporating disease-specific variables would greatly complicate the analysis and interpretation because of considerable variation across cancer types. Future planned analyses of this dataset on a cancer-specific basis will explore in much greater detail how disease and treatment factors can help elucidate the extent to which changes in HRQOL are attributable to disease- or symptom-targeted treatments specific to these cancers, to the quality of care rendered to patients with different cancers, or to some other unmeasured factors.

This study provides valuable information not only for researchers who are interested in future descriptive and mechanistic studies but also for clinicians who care for cancer patients. Although all cancers have the potential to negatively impact HRQOL and the reasons for cancer site-specific differences in HRQOL remain to be explored, the current study identifies particular cancer types that warrant special attention on the part of clinicians. Certain cancers, such as non-small cell lung cancer, are associated with particularly large decrements in both physical and mental health. The results of this study will provide a reference point to allow researchers and clinicians to interpret results of clinical trials and treatments, as compared with older cancer patients across the United States. These findings provide empirical validation for what clinicians perhaps already know about the negative effects of cancer; however, they advance our knowledge by quantifying these effects and providing an evidence base for future research and clinical interventions aimed at understanding and remediating them.

## References

1. Lipscomb J, Donaldson MS, Hiatt RA. Cancer outcomes research and the arenas of application. *J Natl Cancer Inst Monogr*. 2004;33:1–7.
2. Baker F, Haffer SC, Denniston M. Health-related quality of life of cancer and noncancer patients in Medicare managed care. *Cancer*. 2003;97(3):674–681.
3. Hewitt M, Rowland JH, Yancik R. Cancer survivors in the United States: age, health, and disability. *J Gerontol*. 2003;58(1):82–91.
4. Ellis BH, Shannon ED, Cox JK, Aiken L, Fowler BM. Chronic conditions: results of the Medicare Health Outcomes Survey, 1998–2000. *Health Care Financ Rev*. 2004;25(4):75–91.
5. Keating NL, Norredam M, Landrum MB, Huskamp HA, Meara E. Physical and mental health status of older long-term cancer survivors. *J Am Geriatr Soc*. 2005;53(12):2145–2152.
6. Sweeney C, Schmitz KH, Lazovich D, Virnig BA, Wallace RB, Folsom AR. Functional limitations in elderly female cancer survivors. *J Natl Cancer Inst*. 2006;98(8):521–529.
7. Bellizzi KM, Rowland JH. Role of comorbidity, symptoms and age in the health of older survivors following treatment for cancer. *J Aging Health*. 2007;3(5):625–635.
8. Smith AW, Reeve BB, Bellizzi KM, et al. Cancer, comorbidities, and health-related quality of life of older adults. *Health Care Financ Rev*. 2008;29(4):41–56.
9. Colditz GA. The Nurses' Health Study: a cohort of US women followed since 1976. *J Am Med Womens Assoc*. 1995;50(2):40–44.
10. Trentham-Dietz A, Sprague BL, Klein R, et al. Health-related quality of life before and after a breast cancer diagnosis. *Breast Cancer Res Treat*. 2008;109(2):379–387.
11. Amba A, Warren JL, Bellizzi K, Topor M, Haffer SC, Clauser SB. Overview of the SEER—Medical Health Outcomes Survey linked dataset. *Health Care Financ Rev*. 2008;29(4):5–21.



12. Jones N, Jones SL, Miller NA. The Medicare Health Outcomes Survey program: overview, context, and near-term prospects. *Health Qual Life Outcomes*. 2004;2:1–10.
13. Ries LAG, Melbert D, Krapcho M, et al., eds. SEER Cancer Statistics Review, 1975–2004, National Cancer Institute, based on November 2006 SEER data submission, posted to the SEER Web site, 2007. [http://seer.cancer.gov/csr/1975\\_2004/](http://seer.cancer.gov/csr/1975_2004/). Accessed August 28, 2008.
14. McCall N, Bonito A, Trofimovich L. Estimation and analysis of non-response bias in Medicare surveys. Final report prepared by RTI International for the National Committee for Quality Assurance and Centers for Medicare & Medicaid Services under contract #500-00-0055. [http://www.hosonline.org/surveys/hos/download/Non-Response%20Bias%20Report\\_8-11-04.pdf](http://www.hosonline.org/surveys/hos/download/Non-Response%20Bias%20Report_8-11-04.pdf). Accessed February 12, 2009.
15. Haffer SC, Bowen SE. Measuring and improving health outcomes in Medicare: the Medicare HOS program. *Health Care Financ Rev*. 2004; 25(4):1–3.
16. Ware JE, Sherbourne CD. The MOS 36-Item Short-Form Health Survey (SF-36®), I: conceptual framework and item selection. *Med Care*. 1992;30(6):473–483.
17. Turner-Bowker DM, Bartley PJ, Ware JE Jr. *SF-36® Health Survey & “SF” Bibliography: Third Edition (1988–2000)*. Lincoln, RI: QualityMetric Inc; 2002.
18. Rosenbaum PR, Rubin DB. The central role of the propensity score in observational studies for causal effects. *Biometrika*. 1983;70(1):41–55.
19. Rosenbaum PR, Rubin DB. Constructing a control group by multivariate matched sample methods that incorporate the propensity score. *Am Stat*. 1985;39(1):33–38.
20. D’Agostino RB Jr. Propensity score methods for bias reduction in the comparison of a treatment to a non-randomized control group. *Stat Med*. 1998;17(19):2265–2281.
21. Reeve BB, Smith AW, Arora NK, Hays RD. Reducing bias in cancer research: application of propensity score matching. *Health Care Financ Rev*. 2008;29(4):69–80.
22. Bergstralh E, Kosanke J. GMATCH SAS Macro. Mayo Clinic. <http://mayoresearch.mayo.edu/mayo/research/biostat/sasmacros.cfm>. Accessed August 28, 2008.
23. Austin PC. A critical appraisal of propensity-score matching in the medical literature between 1996 and 2003. *Stat Med*. 2008;27(12): 2037–2049.
24. Jaeschke R, Singer J, Guyatt GH. Measurement of health status: ascertaining the minimal clinically important difference. *Control Clin Trials*. 1989; 10(4):407–415.
25. Hays RD, Woolley JM. The concept of clinically meaningful difference in health-related quality of life research. *Pharmacoeconomics*. 2000;18(5): 419–423.
26. Norman GR, Sloan JA, Wywich KW. Interpretation of changes in health-related quality of life: the remarkable universality of half a standard deviation. *Med Care*. May 2003;41(5):582–592.
27. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988.
28. Hays RD. Approaches and recommendations for estimating minimally important differences for health-related quality of life measures. *COPD*. 2005;2(1):63–67.
29. Schünemann HJ, Guyatt GH. Commentary—Goodbye M(C)ID! Hello MID, where do you come from? *Health Serv Res*. 2005;40(2):593–597.
30. Ware JE, Kosinski M, Keller SK. *SF-36® Physical and Mental Health Summary Scales: A User’s Manual*. Boston, MA: The Health Institute; 1994.
31. American Cancer Society. *Cancer Facts & Figures 2008*. Atlanta, GA: American Cancer Society; 2008.
32. Surveillance, Epidemiology, and End Results (SEER) Program. Prevalence database: US Estimated Complete Prevalence Counts on 1/1/2004. National Cancer Institute, Division of Cancer Control and Population Sciences, Surveillance Research Program, Statistical Research and Applications Branch, released April 2007, based on SEER data submission. [www.seer.cancer.gov](http://www.seer.cancer.gov). Accessed August 28, 2008.
33. Institute of Medicine. *Cancer Care for the Whole Patient: Meeting Psychosocial Health Needs*. Nancy E Adler, Ann EK Page, eds. Washington, DC: The National Academies Press; 2008.
34. Bacon CG, Giovannucci E, Testa M, Kawachi I. The impact of cancer treatment on quality of life outcomes for patients with localized prostate cancer. *J Urol*. 2001;166(5):1804–1810.
35. Madalinska JB, Essink-Bot M-L, de Koning HJ, Kirkels WJ, van der Maas PJ, Schröder FH. Health-related quality of life effects of radical prostatectomy and primary radiotherapy for screen-detected or clinically diagnosed localized prostate cancer. *J Clin Oncol*. 2001;19(6):1619–1628.
36. Korfage IJ, Essink-Bot M-L, Borshoom GJJM, et al. Five-year follow-up of health-related quality of life after primary treatment of localized prostate cancer. *Int J Cancer*. 2005;116(2):291–296.
37. Michael YL, Kawachi I, Berkman LF, Homes MD, Colditz GA. The persistent impact of breast carcinoma on functional health status: prospective evidence from the Nurses’ Health Study. *Cancer*. 2000;89(11): 2176–2186.
38. Nekhlyudov L, Kroenke CH, Jung I, Homes MD, Colditz GA. Prospective changes in quality of life after ductal carcinoma-in-situ: results from the Nurses’ Health Study. *J Clin Oncol*. 2006;24(18):2822–2827.
39. Kroenke CH, Rosner B, Chen WY, Kawachi I, Colditz GA, Holmes MD. Functional impact of breast cancer by age at diagnosis. *J Clin Oncol*. 2004;22(10):1849–1856.
40. Morgan RO, Virnig BA, DeVito CA, Persily NA. The Medicare-HMO revolving door—the healthy go in and the sick go out. *N Engl J Med*. 1997;337(3):169–175.
41. Pourat N, Kagawa-Singer M, Wallace SP. Are managed care Medicare beneficiaries with chronic conditions satisfied with their care? *J Aging Health*. 2006;18(1):70–90.
42. Jensen GA, Morrissey MA. Are healthier adults choosing managed care? *Gerontologist*. 2004;44(1):85–93.
43. Donaldson GW, Moynihan CM. Learning to live with missing quality-of-life data in advance-stage disease trials. *J Clin Oncol*. 2005;23(30):7380–7384.

## Funding

The National Cancer Institute funded the collection of cancer data from the Surveillance, Epidemiology, and End Results registry, and the Centers for Medicare & Medicaid Services supported the Medicare Health Outcomes Survey. No grants were awarded for this study.

## Notes

The data analysis, interpretation of the findings, the preparation of the manuscript, and the decision to submit the manuscript were the sole responsibilities of the authors.

The Medicare Health Outcomes Survey was designed by the Centers for Medicare & Medicaid Services to evaluate the performance of Managed Care Plans under contract with the Centers for Medicare & Medicaid Services. The National Cancer Institute Surveillance, Epidemiology, and End Results program currently collects and publishes cancer incidence and survival data from population-based cancer registries covering approximately 26% of the US population. B. B. Reeve is a National Cancer Institute employee and S. C. Haffer is a Centers for Medicare & Medicaid Services employee, but the authors were not involved in designing the surveys or collecting the data.

We gratefully acknowledge Anita Ambs (National Cancer Institute), Marie Topor, and Christopher Zeruto (Information Management Service, Inc.) for their assistance to create the dataset for this study. We also thank Dr Kathryn Taylor (Lombardi Comprehensive Cancer Center, Georgetown University) for her helpful review and advice.

Manuscript received December 10, 2008; revised March 6, 2009; accepted April 9, 2009.